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LISTS OF SPECIES

Bats (Mammalia: Chiroptera) in urban fragments of Maringá, Paraná, Brazil

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ABSTRACT: Bat assemblages in two urban fragments of Maringá city, north of the state of Paraná, southern Brazil, were inventoried. These fragments, Parque do Ingá (48 ha) and Parque Florestal dos Pioneiros (59 ha), are located in a subtropical region covered by semideciduous Atlantic forest. Bats were sampled with mist-nets from August 2006 to July 2007, over 24 nights (12 hours a night), adding up to a total of 30,240 h.m2 of net effort. A total of 839 individuals were captured belonging to 10 species and four families. Artibeus lituratus was the most abundant species (66% of the sample). The observed richness represents 22% of the bat species recorded for the state, 24% of the bat species occurring in the seasonal semideciduous forest of Paraná, 26% of the species previously recorded in urban environments in Brazil, and 83.4% of the estimated richness by Jackknife 1 (n= 12 species). Studies that provide data on richness and abundance of bat species in urban fragments are becoming increasingly important, but are still poorly available in Brazil. This habitat is especially interesting because anthropogenic pressure can be harmful to bat assemblages, reducing their diversity.

INTRODUCTION

In the Neotropical region, the order Chiroptera represents the second largest mammalian group in species diversity. More bat species are often recorded in a given area than are all other mammals combined (Emmons and Feer 1997). The majority of bat species are captured in low numbers and few species are numerically dominant in communities (Bernard 2001; Estrada and Coates-Estrada 2001). In urban environments, bat communities typically have low species richness (Brosset *et al.* 1996; Vaughan *et al.* 1997), associated to the loss or modification of shelter conditions and foraging sites (Avila-Flores and Fenton 2005). However, some species of bats have been shown to resist anthropogenic effects and sometimes even benefit from them, either by inhabiting urban forest fragments or settling directly in urbanized areas (Bredt and Uieda 1996; Fenton 1997; Esberárd 2003; Reis *et al.* 2003; Barros *et al.* 2006). Considering that a better understanding of the influence of urban areas in communities of tropical bats is required (Hourigan 2006), we present here a list of bat species recorded in forest fragments in the municipality of Maringá, state of Paraná, Brazil.

MATERIALS AND METHODS

The two sampled areas, Parque Municipal do Ingá (PMI; 51°55' W, 23°25' S) and Parque Florestal dos Pioneiros (PFP; 51°56' W, 23°25' S), are urban fragments located in the urban central matrix of the city of Maringá, state of Paraná, Brazil (Figure 1). The PMI covers an area of 48 ha and has large trails in its interior. It is crossed by the Moscados river, which now forms a large reservoir located in the center of the fragment (Prefeitura Municipal de Maringá 1994), and is surrounded by street lighting. The PFP covers an area of 59 ha and is crossed by the Cleópatra Stream (Figure 1). There are no trails in this latter area, except for those opened specifically for the current study.

These fragments are covered by seasonal semideciduous Atlantic forest (Veloso *et al.* 1991), altered by anthropic action (Prefeitura Municipal de Maringá 1994) and isolated from other larger forested areas. The climate of the region is subtropical (Cfb according to Köppen's classification), without a marked dry season, and with a mean annual rainfall of 1,517 mm. During the sampling year, rainfall reached a monthly peak of 275 mm (January and September) and the dry and rainy seasons were clearly marked (Climatologic station of Maringá/ PR – Universidade Estadual de Maringá).

Captures were conducted using six mist nets (7 x 2.5 m) placed 0.5 m above the ground in potential flight corridors. These nets were opened from dusk to dawn (12 hours), during 24 nights, from August 2006 to July 2007. All captures were made during the waning moon phase. Species identification followed Barquez *et al.* (1999), Gregorin and Taddei (2002), and Miranda *et al.* (2011), and the taxonomic arrangement followed Gardner (2008). The conservation status of each species in the table was based on the IUCN (2012) red list. The frequency status was based on Pacheco *et al* (2010). Voucher specimens, collected under the license 048/2006 (IBAMA), were fluid-preserved with the skull removed, and are housed in the mammal scientific collection of the Departamento de Zoologia, Universidade Federal do Paraná (UFPR/DZUP/ CCMZ).

The capture effort was calculated according to Straube and Bianconi (2002). The asymptote of the curve and the estimates of species richness were calculated using first-order Jackknife with the aid of the software EstimateS 7.5, both with 1,000 randomizations.

Results and Discussion

A total of 839 individuals from 10 bat species were captured (Table 1), adding up to a total of 30,240 h.m^2 of net effort. Although not expected for a short collection period, the cumulative species curve showed a tendency to stabilize after 22,680 h.m^2 of net effort, which suggests that the sampling effort was sufficient for recording the species that could be captured using the methodology employed in the present study (Figure 2). Mist nets demand a large capture effort to satisfactorily sample bat species richness. It has been proposed that the minimum effort recommended for Atlantic forest sites in southeastern Brazil should include 1,000 captures (Bergallo *et al*. 2003). In at least one case, however, curve stabilization has been obtained after 700 captures (Esberárd and Bergallo 2008).

The seasonal semideciduous forest in Paraná state harbors at least 60 species (Reis *et al.* 2008). Other short-term studies conducted in this region included samplings in a natural area (Miretzki and Margarido 1999), urban fragments (Ortêncio-Filho *et al.* 2005), an agricultural matrix (Bianconi *et al*. 2004), and reforestation areas (Reis *et al*. 2006). All of these recorded an equal or smaller number of bat species than that found during this study, being three species common to all these inventories: *A. lituratus*, *S. lilium*, and *C. perspicillata*.

Artibeus lituratus was the most frequently captured species (Table 1), a result also obtained in samples from the campus of the Universidade Estadual de Maringá (Prone *et al*. 2012) and in other urban fragments of the region (Reis *et al.* 2003; Ortêncio-Filho *et al.* 2005). The present study obtained 22% of the bat species recorded for the state, 24% of the bat species occurring in the seasonal semideciduous forest of Paraná (Reis *et al*. 2008), 26% of the species previously recorded in urban environments (Pacheco *et al*. 2010), and 83.3% of the estimated richness, calculated using first-order Jackknife (n=12 species).

In the study areas, bats belonging to Phyllostomidae were predominant in both species richness (60%) and abundance (94%), and the guild of frugivorous species was the most represented. This family is remarkably diverse and commonly reported in tropical areas, but decline in regions largely influenced by subtropical climate, due to a low tolerance to cold (Eisenberg and Redford 1992). Vespertilionids and molossids, on the other hand, tend to be well-represented in the bat faunas of southern Brazil, surpassing phyllostomids in species richness (Miretzki 2003; Pacheco *et al.* 2008). The predominance of phyllostomids in our samples can be partially explained

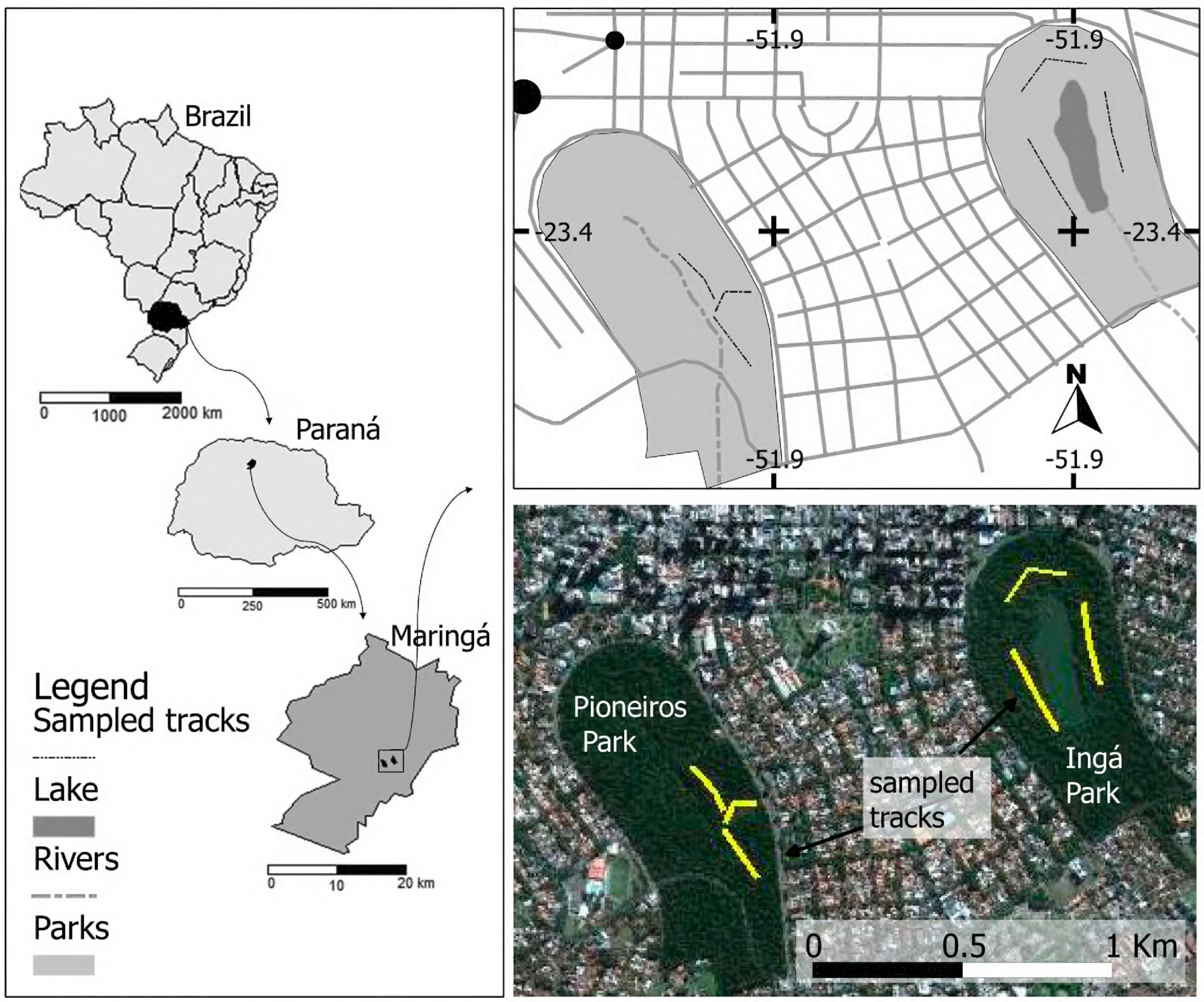

Figure 1. Map showing the study area in Brazil: Parque Municipal do Ingá (PMI), on the right, and Parque Florestal dos Pioneiros, on the left, in the urban area of Maringá, northern Paraná State.

by the high selectivity of the mist nets, favoring the capture of these low-flying bats (Pedro and Taddei 1997), and by the abundance of *A. lituratus*, well known for its ability to persist in urban environments (Lima 2008; Pacheco *et al.* 2010).

Lima (2008) compiled several studies conducted in Brazilian urban parks and found that 63 species (37.7% of bat species recorded in the country) can occur in these areas. Pacheco *et al.* (2010) classified the bat species in the state of Paraná according to their frequency of occurance in urbanized environments, assigning *A. lituratus* as common, *M. molossus* as uncommon, and most other species sampled in this study as rare (*M. neglectus* and *M. riparius* were not cited).

Urban environments provide aerial insectivorous bats with food resources and shelters, favoring their occurrence in great abundance in cities (Rydell 1992; Bredt and Uieda 1996; Silva *et al.* 1996; Lima 2008). In PMI, the presence of bright light from street lighting, attracting large groups of insects, may have favored the capture of insectivorous bats (Rydell 1992). At this site, we also commonly saw molossids hunting around a lake, a resource not available at PFP, where these bats were not sampled.

Although similar in size, shape, vegetation, and presence of a river, the two study areas also differ by the pre-existence of large trails. This may have been reflected in the total number of captures, using the same effort, for both areas. In PMI, three times more bats were captured (649 individuals) than in PFP (190). In areas with the pre-existence of large trails, bats could fly without constantly using echolocation, and thus less able to detect and deflect from the nets (Kunz and Kurta 1988).

Based on the IUCN (2012), all recorded species are classified as "low risk of extinction", except *M. neglectus*, which is classified as "data deficient". *Molossops neglectus* was captured for the first time in the state of Paraná in the PMI (Gazarini and Bernardi 2007), which indicates that others urban fragments of this region deserve a sampling effort for a better understanding of the composition of bat communities and of the distribution of this species in the state.

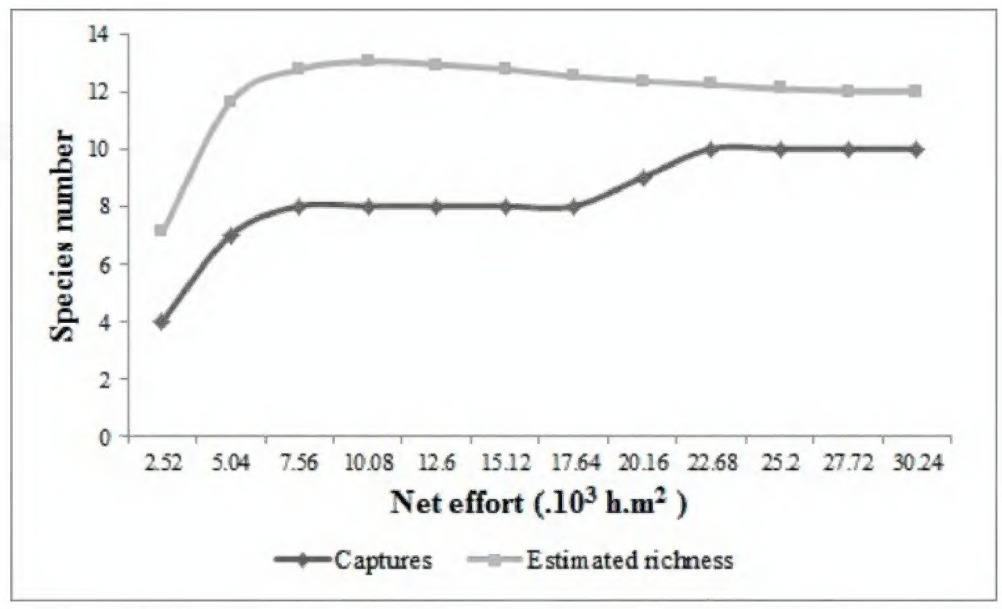

FIGURE 2. Cumulative number of species recorded as a function of capture effort and estimates of species richness (Jackknife 1) in Parque do Inga (PMI) and Parque Florestal dos Pioneiros (PMP), state of Paraná, southern Brazil.

TABLE 1. Species, frequency and conservation status of bats from Parque do Ingá (PMI) and Parque Florestal dos Pioneiros (PFP), state of Paraná, southern Brazil. Frequency status (FS): CO = common, UN = uncommon , RA = rare. Conservation status (CS): LC = Least Concern, DD = Data Deficient.

TAXON	FS	CS	PMI	PFP	TOTAL
Family Phyllostomidae					
Subfamily Phyllostominae					
Phyllostomus hastatus (Pallas, 1767)	RA	LC	3		3
Subfamily Carolliinae					
Carollia perspicillata (Linnaeus, 1758)	RA	LC	1	3	4
Subfamily Stenodermatinae					
Sturnira lilium (É. Geoffroy, 1810)	RA	LC	125	87	212
Artibeus lituratus (Olfers, 1818)	CO	LC	463	89	552
Platyrrhinus lineatus (É. Geoffroy, 1810)	RA	LC	10	2	12
Pygoderma bilabiatum (Wagner, 1843)	RA	LC	7	1	8
Family Noctilionidae					
Noctilio leporinus (Linnaeus, 1758)	RA	LC	1		1
Family Molossidae					
Molossops neglectus Williams and Genoways, 1980	-	DD	13		13
Molossus molossus (Pallas, 1766)	UN	LC	1		1
Family Vespertilionidae					
Eptesicus furinalis (d'Orbigny, 1847)	RA	LC	18	1	19
Lasiurus blossevillii [Lesson, 1826]	RA	LC	1		1
Myotis riparius Handley, 1960	-	LC	6	7	13
TOTAL			**649**	**190**	**839**

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Appendix 1. Voucher list: *Phyllostomus hastatus* (DZUP_MAMMALIA 602), *Carollia perspicillata* (DZUP_MAMMALIA 587–601), *Sturnira lilium* (DZUP_MAMMALIA 608–613), *Artibeus lituratus* (DZUP_MAMMALIA 624–632), *Platyrrhinus lineatus* (DZUP_MAMMALIA 617–620), *Pygoderma bilabiatum* (DZUP_MAMMALIA 592–594), *Noctilio leporinus* (DZUP_MAMMALIA 596), *Molossops neglectus* (DZUP_MAMMALIA 533-538, 503), *Molossus molossus* (DZUP_MAMMALIA 603), *Eptesicus furinalis* (DZUP_MAMMALIA 446, 447, 533–535, 486–492), *Lasiurus blossevillii* (DZUP_MAMMALIA 504, 505), *Myotis riparius* (DZUP_MAMMALIA 494-502, 519–522).